International Journal of Women's Health

Dovepress
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ORIGINAL RESEARCH

Contextual Disparity on Trend and Determinants of Optimal Antenatal Care (ANC4+) Use for Women in Eastern Tigray, Ethiopia: Evidence from KA-HDSS Database

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Background: Though optimal antenatal care (ANC4+) use is absolutely critical, only 43% of women had ANC4+ in Ethiopia and nearly 64% in Tigray in 2019. Furthermore, only 20% of women had their first ANC visit during their first trimester in 2016. However, there is no literature on area based disparity of ANC4+ use in Tigray. Therefore, this study is aimed to generate evidence for ANC4+ use using the Kilite-Awlaelo Health and Demographic Surveillance System (KA-HDSS) database.

Methods: A population-based longitudinal study was employed on 5,414 women from 12 kebelles included in the KA-HDSS site of Tigray. A pregnancy database was used as a source of data. A Line graph was used to depict the trend of ANC4+ use. A stratified robust Poisson model was fitted to estimate the incidence rate ratio (IRR) for women from rural and urban areas separately.

Results: The ANC4+ coverage was 36.3% (95% CI=35.0–37.6%) – 34.2% in rural versus 52.8% urban areas, with an increasing linear trend. Single marital status (IRR=1.29; 95% CI=1.17–1.42); able to read and write (IRR=1.15; 95% CI=1.01–1.32); primary education (IRR=1.22; 95% CI=1.11–1.34); ANC follow-up (2015–2018) (IRR=1.42; 95% CI=1.23–1.64); previous pregnancy exposure (IRR=2.20; 95% CI=1.98–2.45); and having 6+ children (IRR=1.11; 95% CI=1.01–1.21) determined ANC4+ use for rural women. Marital status (Divorced/widowed/separated) (IRR=0.79; 95% CI=0.66–0.95); primary education (IRR=1.44; 95% CI=1.16–1.79); ANC follow-up (2015–2018) (IRR=2.00; 95% CI=1.59–2.50); previous pregnancy exposure (IRR=1.54; 95% CI=1.31–1.80); and having 6+ children (IRR=1.18; 95% CI=1.07–1.31) determined the ANC4+ use for urban women.

Conclusion: The optimal ANC coverage is significantly low, with significant disparity by geographical area and increasing trend. However, further efforts have to be made to maximize the optimal use of ANC, particularly for women from rural areas.

Keywords: determinants, optimal ANC, women, KA-HDSS, trend, Tigray

Introduction

Recently the World Health Organization (WHO) recommended optimal Antenatal Care (ANC) is defined as a minimum of eight visits, in which the first visit is supposed to be held during the first trimester (up to 12 weeks), two visits during the second trimester, at 20 weeks and 26 weeks of gestation, and five visits during the third trimester, at 30, 34, 36, 38, and 40 weeks of gestation with proven evidence of physical contact between the pregnant women and a skilled birth attendant. In practice, however, the recommendation is designed in an adaptable and flexible manner so that countries can adopt and implement the recommendations according to their context and needs.[1] That's why four ANC visits (ANC4+) with the first visit before 14 weeks of gestation is considered adequate and cost-effective for women with no pregnancy complications.[2–4] The recent WHO ANC model is designed to take into account the ever increasing perinatal mortality due to inadequate coverage or poor quality ANC service.[5,6]

Received: 3 December 2022
Accepted: 24 March 2023
Published: 4 April 2023

Maternal health access to quality and comprehensive health care are basic human rights. Maternal health has been considered as a priority issue that became a global health and development agenda in the fourth international conference of women held in 1995, the 1990–2015 Millennium Development Goals (MDGs) and post 2015 Sustainable Development Goals (SDGs).[7,8] Despite this fact more than 300,000 women died, with an average of 830 deaths every day, in 2015 globally as a result of pregnancy and childbirth related complications. Low and Middle Income Countries (LMICs) shared 99% of the deaths.[9,10] MDG 5b calls for universal access to reproductive health for all women by 2015, as measured by ANC coverage, Contraceptive Prevalence Rate (CPR), unmet family planning need, and adolescent birth rates. Although gains were made in each indicator, uneven and insufficient change has been made so far.[8,11]

Literature has revealed that women with lower ANC visits (3 or less) had higher rates of perinatal mortality, even in those uncomplicated pregnancies from Sub-Saharan Africa (SSA) and South Asia. Globally, over 86% of women had first ANC coverage, of which only 50% had fourth ANC coverage that ranged from 46% in South Asia to 52% in the SSA region.[5,6,12]

In Ethiopia, the first ANC and ANC4+ coverages were reported to be 74% and 43%, respectively, with relatively higher optimal ANC visits (nearly 64%) in Tigray according to the Ethiopia Mini Demographic and Health Survey (EMDHS) 2019.[13,14] This was much lower than the country's Health Sector Transformation Plan (HSTP) 2015/16–2019/20 that was planned to achieve 95% by the middle of the HSTP.[15] However, very limited literature is available on optimal ANC and its determinants in the study setting. Even the available literature is either cross-sectional in nature or facility based studies that might lack representativeness to the broader community. Thus, the current study was designed and employed to examine the urban–rural disparity of optimal ANC coverage, trends and determinants using the Kilite-Awlaelo Health and Demographic Surveillance System (KA-HDSS) database. In addition, a robust and rigorous statistical modeling approach was employed to estimate the effect size – incidence rate ratio (IRR).

Methods

Study Setting and Design

A population-based longitudinal study was conducted by KA-HDSS in the Eastern Tigray region of Ethiopia. KA-HDSS was founded by Mekelle University in nine rural kebelles and one urban kebelle as of April 2009. In 2009, baseline socio-demographic characteristics of 65,848 individuals nested in 14,455 households were captured. A unique code was given to every enumerated cohort and household to facilitate linking information during longitudinal observation. So far 11 updates for a population of 101,146 embedded in 21,688 households from 12 kebelles (9 rural and 3 urban) have been made. Though data updates were made regularly every six months, events were captured whenever they happened.[16]

Population, Inclusion Criteria, and Sample Size

All women who had at least one ANC visit for their recent pregnancy and who were within the database in the KA-HDSS site of Tigray were included in the current study. First, 6,122 reproductive women had ANC data. However, the final analysis was based on 5,414 reproductive women (4,810 rural and 604 urban women) who had complete data on the number of ANC visits for their last pregnancy.

Data Source and Study Variables

The data source for the current study was mainly the pregnancy observation table of the KA-HDSS database.

Outcome Variable

The outcome variable is optimal ANC use. The number of ANC visits for the last pregnancy was used as a proxy indicator of the outcome variable. Women who had at least four ANC visits for their recent pregnancy were considered as optimal ANC service users while the remainder were considered as non-optimal ANC service users. Thus, the outcome variable is dichotomous, which was coded as 1 if the woman had ANC4+ and 0 if the woman had no ANC4+.

Explanatory Variables

These were classified as socio-demographic variables (age, ethnicity, religion, place of residence, marital status, occupation and educational status) and maternal-related variables (ANC follow-up year, previous experience of pregnancy, mother's vaccination, HIV testing, number of children and sleep bed nets use during pregnancy).

Statistical Methods of Data Analysis

First, data were cleaned and then analyzed in STATA version 14.2 statistical software. A frequency table was used to describe the background characteristics of women. Age of the women was described using mean±standard deviation. A line graph was used to observe the trend of optimal ANC coverage for all women, rural and urban women separately. Cross-tabulation was used to see the crude association following assessment of cell count adequacy, an important assumption of Pearson chi-square. Later, residence was used as a stratification variable to see the disparity in optimal ANC coverage for reproductive women using stratified robust Poisson regression analysis.

The ANC4+ coverage among all women who had at least one ANC visit for their last pregnancy was 36.3% (34.2% for rural and 52.8% for urban women). The odds ratio (OR) is only a good estimator of the Risk Ratio (RR) when the event of interest is rare. However, in our case the outcome of interest is common and, thus, the RR/IRR is recommended to be estimated directly from the log binomial model or modified (robust) Poisson modeling approach. As a result, two generalized linear models (GLMs) of Poisson family with log link function and robust standard errors (robust Poisson models) were fitted to identify the determinants of optimal ANC visit for rural and urban women separately. Variance inflation factor (VIF) or reverse of VIF (tolerance) was used to check collinearity between variables. Thus, collinearity is not problematic in the two models (mean VIF=1.93 for model I (rural women) and mean VIF=1.81 for model II (urban women)). Moreover, IRR was directly estimated from the stratified robust Poisson model. Maximum likelihood estimation (MLE) is used to estimate the regression parameters. Finally, a decision was made using 95% confidence interval (CI) for IRR.

Results

Background Characteristics of Reproductive Women with at Least One ANC Visit

The mean and standard deviation for age of women at first pregnancy was 31.1±7.0 years. Almost all (98.5%) of the women were orthodox Christian followers. Above two-thirds (69.2%) of the women were married; nearly half (51.9%) could not read and write and above half (56.5%) were housewives.

With regard to ANC4+ use, the service utilization was relatively higher for women aged 25–34 years (38.9%) than women of 15–24 years (35.0%) and 35–49 years (33.5%). In addition, it was higher in women who were single (41.6%), merchants (49.0%), or had a primary level of education (44.2%). Most importantly, ANC4+ use had significant disparity by place of residence – 52.8% in urban dwellers as compared to 34.2% of women from rural areas (Table 1).

Table 1 Background Characteristics of Women Who Had ANC Follow-Up in KA-HDSS Site of Tigray, Ethiopia, 2010–2018 (n=5,414)

Socio-Demographic Variable		Total Number (%)	Optimal ANC use		X^2 (df)	Sig.
			No (%)	Yes (%)		
Age group	15–24 years	1,187 (21.9)	772 (65.0)	415 (35.0)	13.8190 (2)	0.001
	25–34 years	2,503 (46.2)	1,530 (61.1)	973 (38.9)		
	35–49 years	1,724 (31.9)	1,146 (66.5)	578 (33.5)		
Ethnicity	Tigray	5,373 (99.2)	3,418 (63.6)	1,955 (36.4)	1.6068 (1)	0.205
	Amhara/Oromo/Others	41 (0.8)	30 (73.2)	11 (26.8)		
Religion	Orthodox	5,334 (98.5)	3,406 (63.8)	1,928 (36.2)	4.3939 (1)	0.036
	Muslim/Catholic	80 (1.5)	42 (52.5)	38 (47.5)		

(*Continued*)

Table 1 (Continued).

Socio-Demographic Variable		Total Number (%)	Optimal ANC use		X^2 (df)	Sig.
			No (%)	Yes (%)		
Residence	Rural	4,810 (88.8)	3,163 (65.8)	1,647 (34.2)	80.0447 (1)	<0.001
	Urban	604 (11.2)	285 (47.2)	319 (52.8)		
Marital status	Married	3,748 (69.2)	2,439 (65.1)	1,309 (34.9)	22.4735 (2)	<0.001
	Single	1,294 (23.9)	755 (58.4)	539 (41.6)		
	Divorced/Widowed/Separated	372 (6.9)	254 (68.3)	118 (31.7)		
Educational Level	Cannot read and write	2,808 (51.9)	1,949 (69.4)	859 (30.6)	90.6282 (4)	<0.001
	Can read and write	393 (7.3)	248 (63.1)	145 (36.9)		
	Primary education	1,673 (30.9)	933 (55.8)	740 (44.2)		
	Secondary education	472 (8.7)	279 (59.1)	193 (40.9)		
	College or above	68 (1.3)	39 (57.4)	29 (42.6)		
Occupation (5,379)	Farmer	366 (6.8)	246 (67.2)	120 (32.8)	78.6787 (6)	<0.001
	Government Employee	121 (2.3)	68 (56.2)	53 (43.8)		
	Merchant	393 (7.3)	199 (51.0)	191 (49.0)		
	Home servant/Daily laborer	460 (8.5)	280 (60.9)	180 (39.1)		
	Housewife	3,039 (56.5)	2,068 (68.0)	969 (32.0)		
	Student	829 (15.4)	475 (57.3)	354 (42.7)		
	Others (Unemployed/Driver…)	174 (3.2)	96 (55.2)	78 (44.8)		

Abbreviations: ANC, Antenatal Care; df, degree of freedom.

Maternal Related Characteristics of Reproductive Women

Nearly two-thirds (62.7%) of women had recent ANC follow-up from 2015 to 2018. Nearly six in ten (59.0%) women had no previous pregnancy exposure prior to the current pregnancy. Almost one-fifth (19.9%) of the women had been vaccinated for tetanus. The vast majority (88.5%) of women had tested for Human Immunodeficiency Virus (HIV). More than two-third s (69.2%) of women had five or less (<6) children and 54.3% used bed nets during their last pregnancy.

Based on ANC4+ use, ANC4+ use was higher in women who attended ANC from 2015 to 2018 (46.7%) as compared to those who attended from 2010 to 2014 (18.8%). A significant number of women with previous pregnancy exposure utilized ANC4+

Table 2 Maternal Related Characteristics of Women Who Had ANC Follow-Up in KA-HDSS Site of Tigray, Ethiopia, 2010–2018 (n=5,414)

Maternal Related Variable		Total Number (%)	Optimal ANC visit		X^2 (df)	Sig.
			No (%)	Yes (%)		
ANC follow-up year	2010–2014	2,018 (37.3)	1,638 (81.2)	380 (18.8)	425.1834 (1)	<0.001
	2015–2018	3,396 (62.7)	1,810 (53.3)	1,586 (46.7)		
Previous pregnancy exposure	No	3,194 (59.0)	2,469 (77.3)	725 (22.7)	624.2598 (1)	<0.001
	Yes	2,220 (41.0)	979(44.1)	1241 (55.9)		

(*Continued*)

Table 2 (Continued).

Maternal Related Variable		Total Number (%)	Optimal ANC visit		X^2 (df)	Sig.
			No (%)	Yes (%)		
Mother's vaccination (n= 2,447)	Yes	487 (19.9)	468 (96.1)	19 (3.9)	721.0984 (1)	<0.001
	No	1,960 (80.1)	567 (28.9)	1,393 (71.1)		
HIV testing (n= 4,970)	Yes	4,399 (88.5)	2,943 (66.9)	1,456 (33.1)	2.5400 (1)	0.111
	No	571 (11.5)	401 (70.2)	170 (29.8)		
Number of children	Five or less (<6)	3,748 (69.2)	2,407 (64.2)	1,341 (35.8)	1.5028 (1)	0.220
	Six or more (6+)	1,666 (30.8)	1,041 (62.5)	625 (37.5)		
Sleep bed nets used during pregnancy	Yes	2,939 (54.3)	1,948 (66.3)	991 (33.7)	18.7099 (1)	<0.001
	No	2,475 (45.7)	1,500 (60.6)	975 (39.4)		

(55.9%) compared to those who did not (22.7%). However, the figures were almost similar for women according to the HIV testing result and parity (Table 2).

Trends of Optimal ANC Coverage for Reproductive Women

Overall, 5,414 reproductive women had complete data on the number of ANC visits for their last pregnancy, with a median of three (three in rural versus four in urban area). Based on the ANC attendance and number of ANC visits, 1,966 (36.3%; 95% CI=35.0–37.6%) of them had optimal use of the ANC service. The optimal ANC service utilization was higher in urban women, at 319 (52.8%; 95% CI=48.7–56.9%) as compared to rural women, at 1,647 (34.2%; 95% CI=32.9–35.6%). The trend of optimal ANC visit was decreased from 9.9% in 2010 to 6.1% in 2013, increased back to 32.9% in 2014, dramatically decreased to 14.5% in 2015, and then almost linearly increased to 54.1% in 2018 for reproductive women of rural residence (R^2=0.7425). Likewise, the trend was slightly increased from 12.5% in 2010 to 15.4% in 2011, dramatically decreased to 4.2% in 2013, rapidly increased to 73.6% in 2014, decreased to 50.0% in 2015, and then significantly increased to 98.9% in 2017, though there was slight decrement to 96.3% in 2018 for urban women (R^2=0.8008). Similarly, the trend of optimal use of ANC had an increasing linear trend for women of 15–49 years, irrespective of their place of residence and the line is used as a reference line to observe whether optimal ANC use is higher for women in urban or rural areas (see Figure 1).

Determinants of Optimal ANC Use Stratified by Place of Residence

Based on the stratified analysis by place of residence; variables that determined optimal ANC use for rural women (Model I) were: single marital status (IRR=1.29; 95% CI=1.17–1.42); able to read and write (IRR=1.15; 95% CI=1.01–1.32); primary education (IRR=1.22; 95% CI=1.11–1.34); an ANC follow-up (2015–2018) (IRR=1.42; 95% CI=1.23–1.64); previous pregnancy exposure (IRR=2.20; 95% CI=1.98–2.45); and having six or more children (IRR=1.11; 95% CI=1.01–1.21). Keeping other variables constant in model I, rural women who were single, could read and write, had primary education, followed their ANC service from 2015 to 2018, had previous pregnancy experience, and had 6+ children had 17% to 42%, 1% to 32%, 11% to 34%, 23% to 64%, 98% to 145%, and 1% to 21% higher optimal ANC visits as compared to their corresponding reference categories.

While variables that determined optimal ANC use for urban women (Model II) were: divorced/widowed/separated marital status (IRR=0.79; 95% CI=0.66–0.95); primary education (IRR=1.44; 95% CI=1.16–1.79); ANC follow-up (2015–2018) (IRR=2.00; 95% CI=1.59–2.50); previous pregnancy exposure (IRR=1.54; 95% CI=1.31–1.80); and having 6+ children (IRR=1.18; 95% CI=1.07–1.31). Keeping other variables constant in model II, the optimal ANC service was increased on average by 44%, 100%, 54%, and 18% in urban women who had primary education, had ANC follow-up from 2015 to 2018, experienced a previous pregnancy, and had six or more children, respectively. Reversely, urban

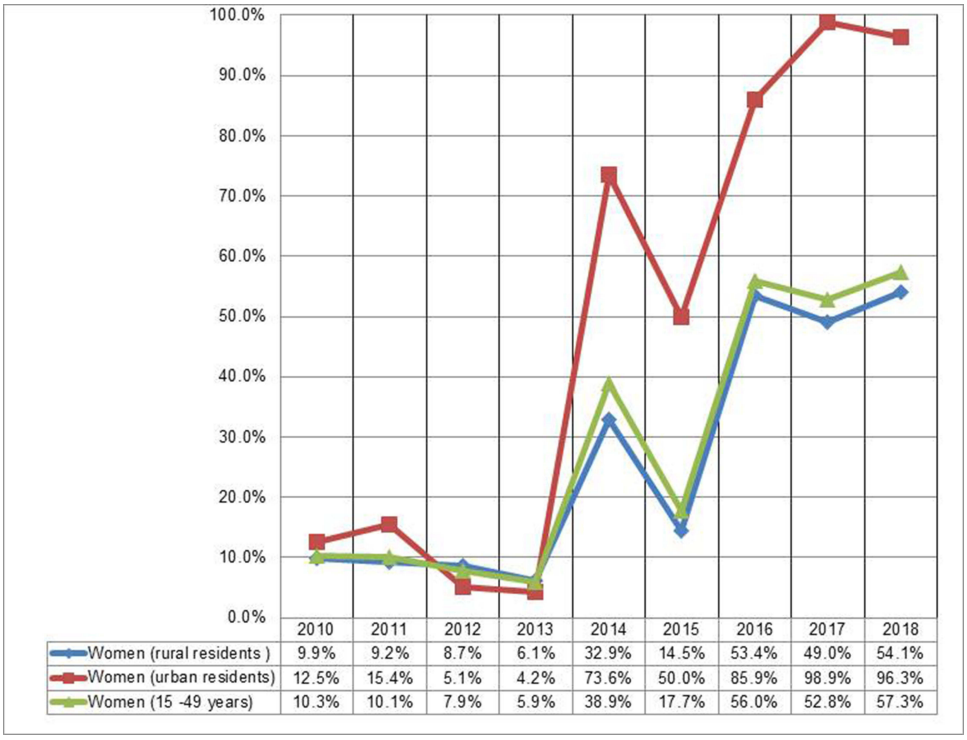

Figure 1 Trends of optimal ANC use among women stratified by residence who had ANC follow-up in KA-HDSS site of Tigray, Ethiopia, 2010–2018.

women who were divorced/widowed/separated reduced the optimal ANC visit by 5% to 34% (21% on average) as compared to the married counterparts (Table 3).

Discussion

The current study is aimed to examine the optimal ANC use, trends, and determinants of optimal ANC use for women stratified by place of residence (rural versus urban) who had at least one ANC follow-up service for their last pregnancy captured by KA-HDSS from 2010 to 2018. The optimal ANC coverage was investigated to be 36.3% (95% CI=35.0–37.6%) with a significantly higher rate reported for urban women (52.8%; 95% CI=48.7–56.9%) as compared to rural

Table 3 Determinants of Optimal ANC Use of Women Using KA-HDSS Database Stratified by Place of Residence, 2010–2018

Variable		Model I: Rural Women (n=4,810)			Model II: Urban Women (n=604)		
		Incidence	IRR (95% CI)	Sig.	Incidence	IRR (95% CI)	Sig.
Age group	15–24 years	33.6%	1.00		42.9%	1.00	
	25–34 years	36.1%	1.01 (0.90–1.14)	0.821	56.2%	1.06 (0.87–1.29)	0.576
	35–49 years	32.2%	0.98 (0.85–1.13)	0.773	59.8%	0.97 (0.76–1.23)	0.782
Religion	Orthodox	34.3%	1.00		52.3%	1.00	
	Others[a]	29.0%	1.00 (0.59–1.69)	0.990	59.2%	1.16 (0.94–1.45)	0.167
Marital Status	Married	32.7%	1.00		54.2%	1.00	
	Single	40.2%	1.29 (1.17–1.42)	<0.001**	56.4%	1.10 (0.92–1.32)	0.308
	Others[b]	27.1%	1.00 (0.80–1.18)	0.768	43.7%	0.79 (0.66–0.95)	0.011*

(*Continued*)

Table 3 (Continued).

Variable		Model I: Rural Women (n=4,810)			Model II: Urban Women (n=604)		
		Incidence	IRR (95% CI)	Sig.	Incidence	IRR (95% CI)	Sig.
Educational level	Cannot read and write	30.3%	1.00		38.1%	1.00	
	Can read and write	36.9%	1.15 (1.01–1.32)	0.037*	40.0%	0.90 (0.50–1.61)	0.722
	Primary	40.5%	1.22 (1.11–1.34)	<0.001**	62.3%	1.44 (1.16– 1.79)	0.001**
	Secondary	37.3%	0.13 (0.96–1.33)	0.133	47.3%	1.18 (0.93–1.49)	0.172
	College or above	31.6%	1.66 (0.87–3.16)	0.122	46.9%	1.19 (0.87–1.64)	0.277
ANC follow-up year	2010–2014	17.0%	1.00		28.4%	1.00	
	2015–2018	43.6%	1.42 (1.23–1.64)	<0.001**	82.4%	2.00 (1.59–2.50)	<0.001**
Previous pregnancy exposure	No	20.4%	1.00		37.3%	1.00	
	Yes	52.8%	2.20 (1.98–2.45)	<0.001**	95.7%	1.54 (1.31–1.80)	<0.001**
Number of children	Five or less (<6)	34.5%	1.00		44.4%	1.00	
	Six or more (6+)	33.7%	1.11 (1.01–1.21)	0.024#	85.5%	1.18 (1.07–1.31)	0.002*

Notes: Others [a]Muslim/catholic; [b]Divorced/widowed/separated; [c]Unemployed/driver, #Relationship may be spurious, *Statistically significant at 5% level of significance, **Significant at 0.1% level of significance.

women (34.2%; 95% CI=32.9–35.6%). Likewise, the trends of optimal ANC coverage had almost linearly increased over time in urban and rural women as well. Based on stratified analysis, marital status, educational level, ANC follow-up year, previous pregnancy experience, and number of children per woman were predicted negatively/positively with the optimal ANC use for urban and/or rural women.

The ANC4+ use was 36.3% with significant disparity that varied by place of residence (34.2% in rural women compared to 52.8% in urban women). This figure is low when compared to even the Ghana optimal ANC coverage based on eight or more visits (41.9%)[17] that might be linked to slightly better maternal and child health services and the recent national ANC4+ coverage in Ethiopia (43%) according to EMDHS 2019 data.[13] However, it is significantly higher than findings reported from Nigeria based on eight visits for optimal ANC (17.4%)[18] and Benin (8%).[19] Based on the stratified analysis by residence, the ANC4+ coverage was increased from 9.9% in 2010 to 54.1% in 2018 for rural women. Similarly, the trend was linearly increased from 12.5% in 2010 to 96.3% in 2018 for urban women. This finding is consistent with data from the EDHS 2016 provided that 41% of urban and 10% of rural women had the recommended ANC visits for their last pregnancy.[20] In addition, the trend was linearly increased from 10% in 2000,[21] 12% in 2005,[22] 19% in 2011,[23] 32% in 2016,[20] and 43% in 2019[13] though the ANC coverage was increased by 47% over the last two decades – from 27% in 2000 to 74% in 2019.[13,20–23] Study reports from Bangladesh, Vietnam, Indonesia, and Nigeria strengthened the current study findings with a markedly increased disparity in optimal ANC visits for urban women as compared to rural women.[24–27] Furthermore, it is also consistent with three studies conducted in Ethiopia using the EDHS 2016 and EMDHS 2019 data which reported urban women were more likely to have the recommended WHO ANC visits of four or more during their recent pregnancy.[14,28,29] The significantly lower optimal ANC coverage for rural woman might be linked to relatively limited transportation access, low level of literacy, limited exposure to media and low maternal health access when compared to urban women.[14,28,30] In the current study, the majority (56.4%) of rural women had no formal education (illiterate) while nearly 84% of urban women were literate (ie, had primary or above level of education). The higher optimal ANC coverage for urban women when compared to rural women in the current study is assumed to be highly correlated to disparity in knowledge, attitude, and practice towards ANC as evidenced from the literature.[31,32] In addition, it might be associated with socio-economic and access to maternal health care service inequalities between urban and rural areas.[28,33]

Marital status was identified as a significant predictor of optimal ANC use for rural and urban women. The optimal service was increased by 29% in single rural women as compared to the married one, while it was reduced by 21% in

urban women with divorced, widowed, or separated marital status. This finding is inconsistent with one study from rural Ghana that has been reported that optimal ANC visit was reduced by 35% in single women and 67% in divorced women.[34] Most importantly, married women might probably get adequate support from their partner and had relatively better socio-economic status, as evidence has revealed from many studies across the world that boldly stated husband education and/or wealth index were significantly correlated with ANC4+ coverage.[14,24,27,28,30,35–37] The better fourth ANC coverage for single women from rural areas might be interacted with the women's education, as 56.3% of single rural women had a primary level of education as compared 20.2% for married women from rural areas in the present study. The strong interaction with level of education is hypothesized to increase the optimal ANC service.

Women's level of education was the most important predictor that positively significantly correlated with optimal use of the service for rural and urban women, though there was inequality in the optimal use of the service (62.3% in urban versus 40.5% in rural women). In other words, women with a primary level of education increased the service by 22% in rural areas and 44% in urban areas, while rural women who could read and write optimized the service by 15% when compared to women who could not read and write. Our finding is strongly supported by literature from Bangladesh,[30] Vietnam,[27] Ghana,[34] Zambia,[35] Benin,[19] and three studies from Ethiopia[28,38,39] in which all stated educated women had better optimal ANC use as compared to those women with no formal education.

There was also a significant disparity in ANC4+ use by ANC follow-up year in rural and urban areas, with a significant increment in women attending ANC from 2015 to 2018 as compared to women attending ANC from 2010 to 2014, though the association was stronger in urban areas (IRR=1.42 for rural women versus IRR=2.00 for urban women). The most likely reasons might be education level, access to health facility, and women's awareness to maternal and child health is supposed to be increased over time and, thus, women might decide to have frequent visits ultimately to save their life and fetus through prevention of maternal morbidity and mortality, still births, and perinatal mortality.[5,6]

Previous pregnancy exposure increased the optimal ANC visit – it increased by 18% in urban women and 11% in rural women. Women who had previous pregnancy exposure might get a lesson from their actual exposure and could understand the importance of optimal ANC service on maternal and child health outcomes. Furthermore, urban women with six or more children were more likely to utilize the optimal ANC service as compared to women with less than six children (85.5% versus 44.4%). ANC4+ service utilization might be increased as a result of their exposure to multiple pregnancies throughout their life. However, the finding is inconsistent with three studies from Bangladesh, Nepal, and Pakistan that used DHS data and concluded that there was an inverse association between optimal ANC visit and number of children per woman.[24,37,40] However, the association for rural women seems to be spurious (IRR=1.11) as optimal ANC coverage is slightly higher in rural women with less than six children (see Table 3). The positive relationship between six or more children and ANC4+ coverage for rural women in the present study is viewed in another pattern of relationship as bidirectional positive interactions with primary level of education and ANC follow-up from 2015 to 2018 were investigated.

Age was reported to be a significant determinant of optimal ANC coverage in two studies from rural Ghana[34] and Vietnam,[27] particularly poor optimal ANC coverage in youths and adolescents from rural areas. Though there is a difference in ANC4+ coverage of rural women by age group examined; 33.6%, 36.1%, and 32.2% for women of 15–24 years, 25–34 years, and 35–49 years, respectively, differences were not statistically significant in the current study. However, low optimal ANC coverage in youths and adolescents is expected as a result of limited knowledge and experience even for the routine ANC that could be enriched over time.

The current study used a big population-based longitudinal database as the data source, estimated IRR directly using modified Poisson model, stratified analysis by geographical area (rural versus urban) was employed and the ANC4+ coverage was computed from women who had at least one ANC visit for their recent pregnancy. However, there were some limitations. The optimal ANC visit considers only the number of ANC visits as four or more irrespective of the time of visit and contents of ANC services covered at every visit and some studies used ANC visits of eight or more as optimal. Beyond this, some important variables, such as access to health facility for ANC service, distance from the health facility, wealth index, and media exposure were missed and should be investigated in further studies.

Conclusion

The optimal ANC coverage is low, despite the significant difference by geographic area. The trend of the optimal ANC coverage was almost linearly increased over time for women from urban and rural areas. Furthermore, the ANC4+ use was influenced by marital status (other than married), primary education, ANC follow-up year (2015–2018), previous pregnancy exposure and number of children (6+) for women from rural and urban areas. Therefore, further efforts have to be made to maximize the optimal ANC coverage, particularly in rural areas and it is also advisable that all women attain primary level education as there was proven evidence of increasing ANC4+ use in both cases. Further study on the quality of ANC use considering three indicators, namely number of ANC visits, time of visit, and content of services to be provided at each visit is recommended to be conducted.

Abbreviations

ANC, Antenatal Care; ANC4+, Optimal ANC; EDHS, Ethiopia Demographic and Health Survey; GLMs, Generalized Linear Models; HSTP, Health Sector Transformation Plan; IRR, Incidence Rate Ratio; LMICs, Low and Middle Income Countries; MDG, Millennium Development Goal; KA-HDSS, Kilite-Awlaelo Health and Demographic Surveillance System; SDG, Sustainable Development Goal; SSA, Sub-Saharan Africa.

Data Sharing Statement

The dataset has personal or identifiable information including the name of the women. Thus, the datasets used and/or analyzed for this study are available from the KA-HDSS co-ordination office upon reasonable request via the Email address: ka.hdss.2011@gmail.com.

Ethics Approval and Consent to Participate

Ethics approval was issued by the Institutional Review Board (IRB) of Mekelle University College of Health Sciences. Data access was permitted by KA-HDSS office according to the data sharing and use policy provided that data used confidentially for the purpose of the study only. The consent to participate is fully waived as participants were not directly involved in the current study.

Acknowledgments

The authors are grateful for KA-HDSS office for sharing the database to be used for the current study.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no competing interests exist in this work.

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